



# Natural Forces Affecting Boston Beaches

**Grade:** Grade 5/6

**Place of Focus:** Boston Harbor

## Massachusetts Curriculum Framework for Science and Technology/Engineering Standards

- **5-ESS3-1.** Obtain and combine information about ways communities reduce impact on the Earth's resources and environment by changing an agricultural, industrial, or community practice or process.
- **4-PS4-1.** Develop a model of a simple mechanical wave (including sound) to communicate that waves (a) are regular patterns of motion along which energy travels and (b) can cause objects to move.

## Lesson Overview

This lesson will introduce students to the concept of erosion caused by ocean waves, using a simple model, and define and contextualize the term “beach profile.” Students will investigate the influence of waves on beaches under different conditions and observe how the profile of the beach changes over time. Students will then use different materials to explore ways to prevent erosion caused by excessive and amplified wave action.

The goal of this second lesson is to help students connect familiar aspects of beach environments like moving water, wind, and built structures to the physical process of erosion, and through that connection, begin to understand possible ways to avoid erosion linked to human impact and climate change.

## Essential Question

How do we know something is changing?

## Guiding Questions

- What is a model and how can we model natural events?
- What are the forces that cause a coastline to change?
- What techniques are most effective for protecting our modeled coastline?

## Learning Objectives

***By the end of the lesson, participants will be able to:***

- Define and explain erosion, drawing on examples from their own prior experience and observations
- Explain the relationship between ocean waves and erosion
- Understand and discuss different strategies to protect communities from erosion
- Demonstrate how a coastal community might be affected by strong waves by using a model of wave action on a coastline

# Lesson Preparations

## Time

1 hour

## Materials and Supplies

For this activity, students should be split into groups (preferably no more than 3-4 students per group). Each group will need the following:

- Rectangular container, preferably transparent, ~ 6 x 10" (e.g., tupperware)\*
- Flat spatula/paddle\*
- Sand (natural or landscaping sand; *NOT kinetic*; pre-fill in the rectangular containers)
- Rocks of varying sizes (must also fit in rectangular container), sponges, and other materials for erosion protection
- Water
- Markers (dry erase)
- Directions sheet
- Ruler
- Model houses, trees, etc.

## Lesson Outline

### Introduction

#### **Recap Lesson 1 and assess prior understanding (5 min)**

- Ask students to recall the essential question, “How do we know something is changing?”
- Ask students, “What observations can be measured in the world around us?”
- Ask students, “What might cause sand to move around on the beach?”

## Introduction (cont.)

### Local Context: Lovells Island (5 min)

- Show the picture set of erosion at Lovells Island from [NPS website](#). Ask students, “What do you think happened here?”
- Ask students, “How can we answer questions about the beach in our classroom?”
- Define **model** for students. Ask, “How can we use a model to measure change at the beach?”

### Activity Introduction: Modeling Coastline Change (15 min)

*Set up and explain the wave action activity*

- Ask students, “What is a **beach profile**?”
  - Profile: an outline of something as seen from the side
  - Beach profile: the shape of the sand surface if you took a slice of the beach from top to bottom
- Ask students, “How can we measure a beach’s profile in our classroom model?”

Split students into groups of three. Designate three roles:

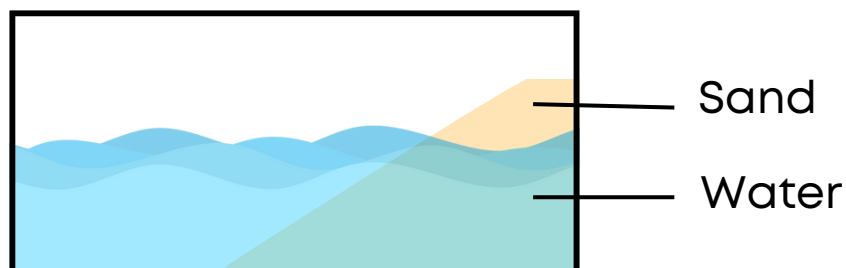
- Student 1: Wave Maker
- Student 2: Timekeeper
- Student 3: Observer

Each group receives one rectangular container, prefilled with sand

- Students arrange the sand to create a slope against one of the narrow ends of the container, modeling a coastline of their choice

Staff member comes around and pours water into each of the containers

- Notice how, by looking through the side of the container, we can see the beach profile (the slope of the beach)



Beach profile model,  
within container

## Lesson Activity: Wave Making and Erosion

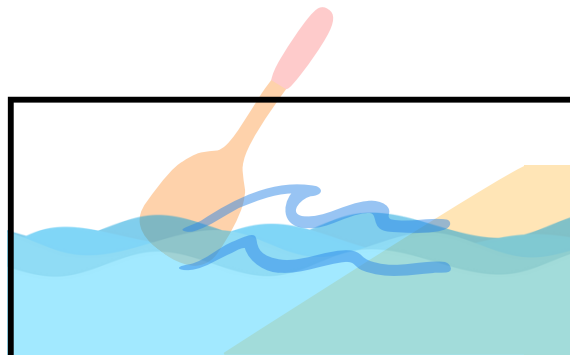
### 3 Wave Experiments (25 min)

- **Experiment 1: Calm Waves**

- Take one minute to build a small community along the model coastline using the provided houses
- Each group draws a line along the side of the container to mark the current beach profile; label the line as “START”
- Each group member writes down predictions about how the profile might change by the end of the activity
- Student 1 starts making waves gentle waves, while Student 2 keeps track of time and Student 3 observes changes to the coastline
- Student 2 calls time stop at the 1-minute mark
- Students record their observations of the current coastline and compare it to the “START” line
- After Experiment 1: groups share observations with the class as a whole (record on the board/in a slideshow presentation)

- **Experiment 2: REPEAT, with storm waves**

- Re-shape the sand to align with the “START” slope, students switch roles
- Student 1 starts making stronger storm waves (staff model technique to avoid splashing), repeat wave-making, time-keeping, and observational activities
- Student 2 calls time stop at the 1-minute mark
- Students record their observations of the current coastline and compare it to the “START” line
- After Experiment 2: groups share observations with the class as a whole (record on the board/in a slideshow presentation)



## Lesson Activity: Wave Making and Erosion (cont.)

- **Experiment 3: REPEAT, with coastal protection**
  - Re-shape the sand to align with the “START” slope, switch roles
  - Student groups to design a beach protection measure using the provided materials (5 minutes)
  - Using the same storm wave technique from Experiment 2, repeat wave-making, time-keeping, and observational activities
  - Student 2 calls time stop at the 1-minute mark
  - Students record their observations of the current coastline and compare it to the “START” line
  - After Experiment 3: groups share observations with the class as a whole (record on the board/in a slideshow presentation)

### Clean-Up

- Designate one person per group to: collect their group’s houses; collect the paddles and markers; and empty the container’s water into either a sink or a bucket (leaving wet sand in the containers to dry later)

## Conclusion and Reflection

- General observations
  - Reflecting on the three experiments, ask students:
  - “How effective were the rocks for protection? What challenges did you find?”
- Show a picture of Constitution Beach
  - Ask students, “What is different between our model and an actual beach?” Notice: This model showed dramatic change in a short amount of time
- Prompt students to think about: “How could we measure real change on a real beach?”
  - Ask students, “What do you know about slope?”
  - Prompt students, “In our model, we looked at our beach profile like it was a slice of the beach - think about how we could measure that without being able to cut the beach in half.”